RAVEN

SEATTLE CITY LIGHT WORK ORDER #87-12

WATER QUALITY AND SEDIMENT TESTING AT THE GEORGETOWN STEAM PLANT CONDENSER PIT

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I. INTRODUCTION

At the Georgetown Steam Plant there is a subterranean pit and drainage system that was constructed to dispose of spent cooling water from the condensers. The two large condensers that serviced the cooling system of the two vertical generators are mounted adjacent to the generators above pits that are continuous with the underground discharge system. The system is connected to the underground tunnel and flume that discharges into the Duwamish Waterway. Some standing water remains in the system. Inside the Steam Plant, the system is comprised of two parts. Beneath the east condenser tower is an antechamber that is U-shaped, extending west to the west condenser and then east toward the flume in a U-shaped configuration. This antechamber connects to the tunnel head. The two parts are separated by a concrete dike. The dike can retain several feet of standing water, even if the tunnel is dry. [See Fig. 1.] The east condenser water inlet (not shown) is 39' to the east of the west condenser inlet. The present system contains standing water and a few sediments. Removal plans for the water and sediments have initiated the present study as authorized by Seattle City Light Work Order #87-12.

The purpose of removing the water is to eliminate it as a source of moisture to the steam plant interior, which accelerates deterioration of historic artifacts. For proper handling and disposal, it was necessary to analyze the water and sediments for PCBs, pH, conductivity, and other contaminants. Water levels in the system were checked to monitor the influence of rainwater inputs and conductivity was tested to determine if tidewater had reached the concrete dike. Physical descriptions of the samples can be found in Table II. The sampling locations appear in Fig. 1.

II. METHODOLOGY

A. Sampling Containers and Equipment

Solid samples for the pit and tunnel sediments were placed in 270 ml wide-mouth glass containers that had been pre-cleaned. The metal screw cap lids were lined with aluminum foil such that the dull side was in contact with the sample.

The pre-cleaning procedure involved scrubbing with a special petrochemical dissolving soap [HarborMaster Products, Inc., Edmonds, Washington]. The terminal end of the brush applied composites had sufficient bristles to scrub the seam where the side connects with the bottom. A final rinsing with hexane was undertaken to remove any invisible greases and detergent residues. The use of methylene chloride was avoided on this project.

All liquid samples were placed in four liter glass screw-capped bottles whose lids were lined with aluminum foil. The final rinsings of these bottles was carried out with nanograde hexane.

The water samples were captured by immersing the sample jug rapidly through the interface and allowing it to fill while slowly lowering it through the water column to obtain an approximate vertical composite. The sample jug was attached to an epoxy-coated fiberglass rod.

Sediment samples were obtained with repeated lancings of the bottom deposits with a special stainless steel snap-grab whose volume was about 50 cc. Usually there was less than 1 inch of sediments.

B. Field Observations

Data on the collection process and observations of the physical nature of the sample were kept in the bound field log book. The format for this book is chronological.

C. Sample Collection

Method 8080 in the EPA SW-846 manual describes the protocol for handling organochlorine compounds. Compliance with these instructions necessitated using glass containers and specified conditions for refrigeration. All samples in our case were delivered to the laboratory in time to comply with the maximum seven days storage for extraction and thirty days for complete analysis. The metals were at concentration levels that allowed their storage in glass containers.

D. Analysis

The water samples were extracted using a separatory funnel extraction method. Sediment samples were subjected to the Sonication Method 3550. The water samples were extracted as follows: 500 ml of the water sample were placed in a one liter separatory funnel and acidified with 4-5 ml of 1:1 sulfuric acid. Sodium chloride was added to saturate the water. The water was extracted three times with 25 ml aliquots of toluene. The toluene extracts were combined and brought to a volume of 100 ml. The soil samples were extracted as follows: Approximately 50 grams of the soil was dried at 50° C and then moistened with 1% sulfuric acid. The soil was re-dried and approximately 10 grams of the dry, acidified soil was extrac- ted using toluene. The basis for detection of chlorophenols was SW-846 Method 8040. The basis for detection of PCBs was Method 8080.

Analysis for pentachlorophenol was made using an HP5890 gas chromatograph equipped with an electron capture detector and capillary column. Detection limits for pentachlorophenol of 0.05 ppm (soil basis) and 0.001 ppm (water basis) were maintained.

Conductivities were measured with an EICO Model 950 comparator bridge. The cells were glass tubes containing platinum black electrodes. A Hanna Model 0624 pH meter was used.

III. RESULTS

Table I reports the results for the various samples as shown. PCBs and PCPs were not detected. The antechamber sediments had significantly higher oil and grease concentrations than did the tunnel sediments, reflecting the result of cleanup of the tunnel sediments that occurred in November, 1985.

The pH values can be interpreted in light of the conductivity tests. Relative conductivity was measured by comparing the water samples to dilute sodium chloride solutions. The conductivities, compared in units of mg/liter of sodium chloride are as follows:

	Conductivity
tunnel mouth water	120
condenser pit water	570

By comparison, the reading for seawater is about 40,000 mg/l. Observations of the levels of water in mid-October showed that the antechamber water level was the same, but the tunnel water level had fallen ~0.7 feet, perhaps due to evaporation during the current drought. The elevation detail is shown in Fig. 2.

On April 21, 1988, some subsequent observations were made. An updated table is shown:

	Water Depth		
	3 Sept 87	14 Oct 87	21 Apr 88
Antechamber	1.7'	1.65'	0.25'
Tunnel Head	3.7'	2.40'	3.25'

The water depth in the pit below the east condenser was 3.25'. Evidently there is not a direct connection between this pit and the antechamber at the bottom, or this water would flow out. The water was stagnant, as surmised from a surface oil sheen. It was not cloudy and was standing above about 1/4" deep rusty appearing sediment.

IV. DISCUSSION

The report from Work Order #87-10, "Compilation of Historic Sampling Results from Georgetown Steam Plant and Environs," discusses the behavior of tidewater in the flume. Since 1982, the agencies concerned with the flume have speculated that tidewater moving in and out of the discharge system has transported contaminated sediments. One clue that the speculation was valid would be the presence of seawater in the antechamber. These studies show that occurrence to be extremely unlikely. The tide in the last two decades that would have definitely breached the concrete dike occurred in December, 1977. So the few salts now present in the antechamber might have originated from that tide. Since the observed pH is 8.2, those few salts also might have originated from the hardness residues associated with alkaline treatment chemicals typical in boiler feedwater introduced when the plant was in operation.

In any event, the water needs to be removed. Disposal of the water via the METRO sewer system is probably the cheapest legal and environmentally sound means, since the results on Table I show the water to be below the contamination threshold for METRO sewers.
The possibility that the antechamber/tunnel system could refill when seasonally heavy rainfalls occur cannot be dismissed; some roof drains from the steam plant had discharge routes which emptied into the antechamber. City Light is in the process of rerouting these roof drains into nearby storm drains. Residual sediments can probably be handled by the Seattle City Light Vactor truck teams and disposed with the accumulated vault sludge from other Vactor truck removals.

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TABLE I

ANALYTICAL RESULTS

Sample #	Location/ Matrix	PCB ppm	PCP ppm	Oil/Grease Gravimetric [ppm]	pH	METALS ppm **						
						As	Cd	Cr	Cu	Pb	Ni	Zn
GB-1	Antechamber water	ND*	ND	1.3	–							
GB-2	Antechamber water	---	---	---	8.2	<1.0	<.006	<.026	<.013	<.02	<.03	<.06
GB-3	Tunnel water	ND	ND	0.3	–							
GB-4	Tunnel water	---	---	---	7.2	<1.0	<.006	<.026	<.013	<.02	<.03	<.05
GB-5	Antechamber water	ND	ND	19.6	–							
METRO limits for water				110	2 - 12	1.0	3.0	6.0	3.0	3.0	6.0	5.0
GB-6	Tunnel sediments	ND	ND	3.2	–	<15	1.35	17.7	59.7	149	5.87	170
GB-8	Sediment	---	---	---	7.1	<1.0	<.006	<.026	<.013	<.046	<.03	<.008

NOTE: Sample GB-7 does not exist.

* ND = <0.01 ppm PCB in sediments and .001 ppm PCB in water. Refer to the text for PCP.

** For Sample #GB-6 and GB-8, leached sediments are reported as ppm dry weight.

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TABLE II

SAMPLE DESCRIPTIONS

Sample #	Location/Matrix	Description
GB-1	Antechamber water	Traces of rust and slight turbidity; very thin oil sheen visible on top
GB-2	Antechamber water	Same as above
GB-3	Tunnel water	Fairly clear stagnant water; no traces of algae
GB-4	Tunnel water	Same as above
GB-5	Antechamber sediments	Foul black oily fine-grained silt with petroliferous odor
GB-6	Tunnel sediments	black coarse- and fine-grained sandy silt; not sticky enough
GB-8	Porewater in sediments [combined]	to core. Repeated grabs were required.

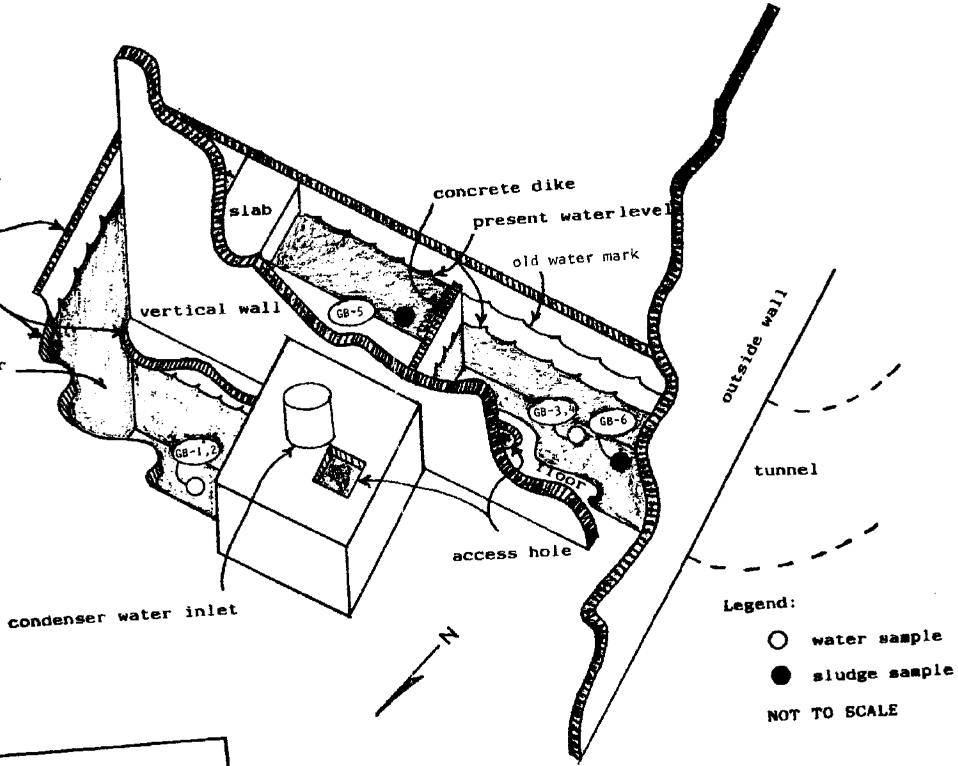
SCL 04019

CTY0049025

SEA289504

GEORGETOWN STEAM PLANT

Condenser Discharge Antechamber and Tunnel



Isometric Projection

RAVEN SYSTEMS and RESEARCH, INC		
SCALE: none	APPROVED BY	DRAWN BY LSG
DATE 14 Oct. '87		REVISED JD
SCL Georgetown Steam Plant - Condenser Pit & Tunnel		DRAWING NUMBER 87-12-1
LA TERRE ENVIRONMENTAL CONS.		

87-12-1

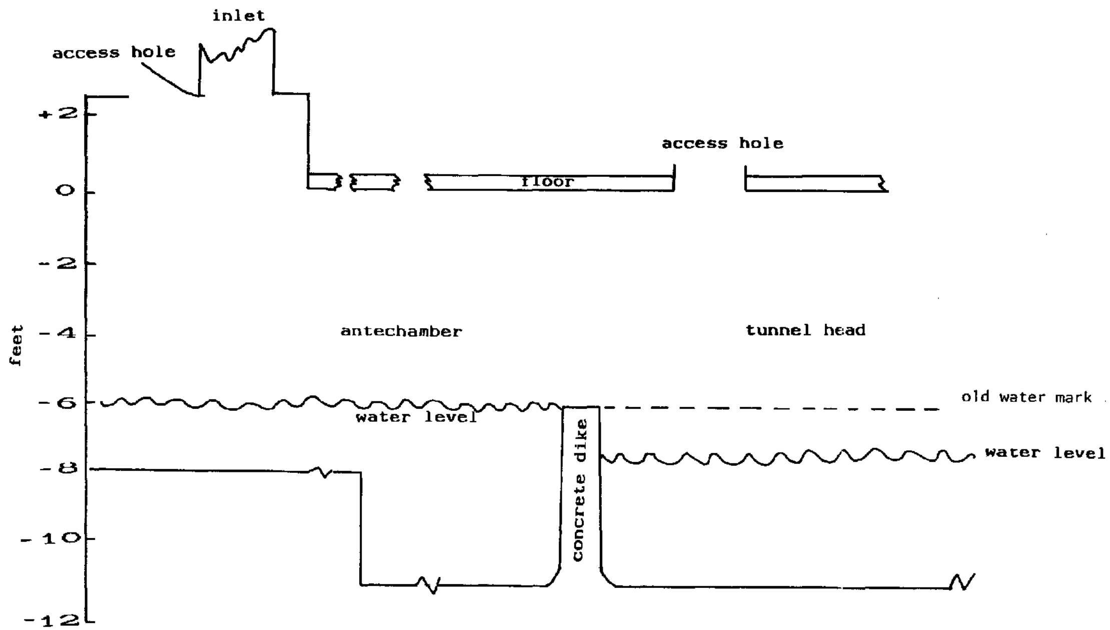
SCL 04020

CTY0049026

SEA289505

GEORGETOWN STEAM PLANT

Elevation Detail



RAVEN SYSTEMS and RESEARCH, INC		
SCALE: vert. shown DATE: 14 Oct. '87	APPROVED BY: [signature]	DRAWN BY LSG REVISED JD
SCL Georgetown Steam Plant - Condenser Pit & Tunnel - Elev. Detail		
LA TERRE ENVIRONMENTAL CONS.		DRAWING NUMBER 87-12-2